NUTRIENT MANAGEMENT IN PEI POTATO PRODUCTION

Key points to consider when making fertility program decisions on your farm

based on presentations at Nutrient Management Workshop, Jan 17th, 2018 by:
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The Role of Nutrients for the Potato Plant:

Like all crops, potatoes require adequate availability of a number of essential nutrients to emerge, establish, develop leaves, mature, and then set and bulk tubers. Some nutrients are required in relatively high amounts, while other are needed at only trace levels in the soil to meet the needs of the plant. Essential nutrients include:

Nitrogen (N): central element for the development of all proteins, including chlorophyll for photosynthesis, nucleic acids (DNA & RNA), and amino sugars. N is often the most limiting nutrient in potato production systems.

Phosphorus (P): important for enhancing early crop growth and promoting tuber maturity.

Potassium (K): plays important role in tuber yield, size and quality. Potato crops take up significant quantities of K, particularly during tuber bulking. Both too little and too much K can have negative impacts on tuber yield and quality.

Calcium (Ca): involved in building cell walls and membrane permeability. Important in maintaining tuber quality in storage and reducing internal tuber disorders.

Magnesium (Mg): plays an important role in the production of chlorophyll. Mg deficiency can occur in acidic, sandy soils or when high rates of K fertilizer are used, as Mg competes with K for plant uptake.

Sulfur (S): an integral component in proteins and many enzymes. S requirements often met through organic matter breakdown, but S is susceptible to leaching on sandy soils and is less prevalent in rainwater than in previous years.

Additional essential nutrients include: Boron (B), Copper (Cu), Clorine (Cl), Iron (Fe), Manganese (Mn), Molybdenum (Mo), Nickel (Ni), and Zinc (Zn).

pH and CEC:

pH is a measure of amount of hydrogen ion in water. It is expressed on a scale of 1 to 14, with a pH of less than 7 said to be acidic, and pH greater than 7 said to be basic. An decrease in one pH unit represents a ten-fold increase in the amount hydrogen ion present.

Soil pH has an effect on the availability of nutrients. Plants take up nutrients in the form of ions (ie. $NO3–$, $NH4+$, $Ca2+$,$H2PO4–$), and often they take up more cations (+) than anions (-). To compensate for the extra positive charge, plants will release H+ ions from their roots.

Soils with extremely low or high levels of pH will tend to have a negative impact on nutrient availability, as cations and anions will be more tightly bound and unable to be absorbed by plants. Some nutrients, like phosphorus, are particularly unavailable in very acidic soils. The average soil pH in Prince Edward Island is 6.0, with a range of 5.0 to 7.2.

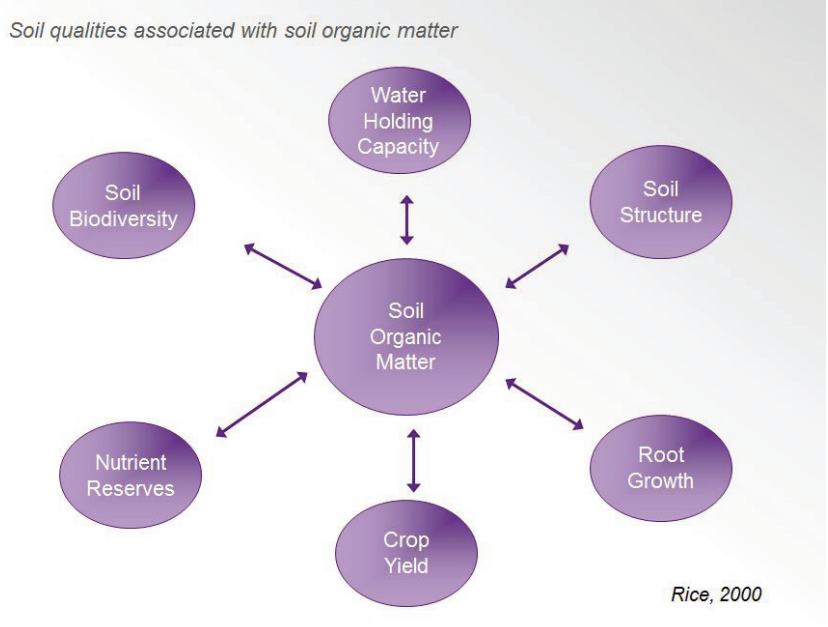
If soils are deemed too acidic, application of lime is recommended. Soil test reports will generate and provide recommendations for how much lime to apply to increase pH to a target value. Lime application can be applied before planting, but is more frequently being applied the year before potato production.

Related to pH is Cation Exhange Capacity (CEC), the total quantity of negative charges on minerals and organic matter available to attract cations in solution expressed as milli-equivalents (meq) of negative charge per 100g of dry soil.

The CEC can be occupied with acidic (H, Al) or basic cations (Ca, Mg, K, Na). The % base saturation measures what percentage of the total CEC is occupied by base cations. Since the base cations are important plant nutrients, maintaining a high % base saturation increases the fertility of the soil.

The Role of Organic Matter in Soil:

Organic matter is fundamental to healthy soils. Not only does it provide nutrients and habitat for soil microorganisms, it also plays an important role in building aggregates in soil. Soils with improved structure have more capacity to hold water, particularly important in rain-fed crop production like is found in the majority of Prince Edward Island. As soil organic matter naturally decomposes, it makes a number of nutrients available for growing plants.



A recent report by the PEI Department of Agriculture and Fisheries has determined that over the past two decades, soil organic matter percentages in all types of rotations have overall been trending downward in Prince Edward Island. This is due to a variety of factors, including changes in rotation and a lack of manure availability due to decline in the livestock sector.

With the challenges presented by climate change and changing weather patterns, it seems certain that Island potato growers will need soils that are more resilient and better able to hold water during dry periods. Therefore, reversing this downward trend in soil organic matter is essential. Factors associated with maintaining or improving soil organic matter include:

- Addition of **manure or compost** as a soil amendment is the fastest way to build soil organic matter.
- **Reduced tillage.** Disturbing the soil activates soil microbes to consume soil organic matter, and also makes soils more sensitive to erosion. Reducing the number of tillage operations has been shown to have a significant impact on improving soil organic matter levels.
- **Leaving crop residues** like straw on the field.
- **Mulching of forage crops** instead of removing as hay or silage.
- **Cover crops.** Having something actively growing in your fields as much as possible is positive for building soil organic matter as well as preventing erosion.
- **Preventing soil erosion** through berms, terraces, and grassed waterways for controlled water flow.

Nutrient Sources:

There are multiple ways to ensure that your crop has sufficient amounts of essential nutrients to produce a profitable crop. Many trace elements are readily available in the soil without requiring addition. Others are required in substantial amounts or are naturally deficient in PEI soils (ie. boron, calcium) so require addition through use of fertilizer or soil amendments.

Among the major nutrients, there are different products that can be used, depending on price, availability, type of crop, how the fertilizer is applied, and what mix of nutrients are required. For example, a grower may choose to apply nitrogen as **urea** (46% N), **ammonium nitrate** (34% N), **ammonium sulfate** (21% N), **calcium ammonium nitrate** (27%), a variety of liquid or foliar products, or through use of manures or composts. There are also a number of slow release N products, including polymer-coated urea (ESN).

Locally, phosphorus is commonly used granularly as **monoammonium phosphate** (MAP - 12% N, 61% P) or **diammonium phosphate** (DAP - 18% N, 46% P). A number of liquid P products are also used, as are slow release products (ie. Crystal Green).

Potassium is most commonly available in PEI as **muriate of potash** (MOP or KCl - 60% K), **potassium sulphate** (SOP or K2SO4 - 50% K, 18% S), or **K-MAG** (22% K, 11% Mg, 22% S). A number of branded, multi-nutrient products such as NK21 or MESZ are also widely used.

Determining Nutrient Rates:

There are a number of key factors to consider when determining what rate of fertilizer to apply to your field:

- **Yield Goal.** The yield of your crop will have direct impact on the amount of nutrient that you remove from the field with that crop. It is important to set realistic yield goals to ensure adequate but not over-fertilization.
- **Soil test results.** Your soil test report provides an amount for each soil nutrient in your field, and whether it is relatively low, medium or high in order to adjust your rate accordingly.
- **Variety.** There is significant difference between varieties on their use efficiency of nutrients, particularly N.
- **Organic Matter.** Soils with higher levels of organic matter (over 3.5%) have an ability to mineralize nitrogen for use by a growing potato crop.
- **Manure/compost.** N, P, and K, along with many other nutrients, are available in manure and compost. These soil amendments should be tested for composition before application to ensure appropriate credit is given. Availability of these nutrients is not generally available all at once; rather, they release over time as the manure/compost decomposes.
- **Plow-down crops.** Forage crops high in nitrogen-fixing legumes (ie. alfalfa, red clover) have the potential to produce significant amounts of N for next year's crop when grown as a cover crop/plow-down crop. Depending on maturity, species, and management of the crop, N credits should be accounted for.

There continues to be a need to determine how much fertility is needed under local conditions to grow a profitable crop of potatoes. New varieties often come with a suggested fertility rate, but it has been necessary to confirm these rates under PEI conditions. In addition, field-specific characteristics such as Base Saturation or P/Al index can have an impact on whether rates should be increased or decreased for that field. Recent PEI research has shown that fields with higher P/Al index scores require lower levels of P to be applied, as relatively low amounts of P are removed with the crop.

Crop Removal Rates:

At a yield of 350 cwt per acre, a potato crop will remove/uptake the following nutrients (lb/acre):

	Tubers	Stems/Leaves
N	105	70
P_2O_5	53	18
K_2O	228	105
S	11	7

Source: IPNI Nutrient Removal Calculator

Nitrogen Credits for Plow-Down Crops (lb/acre)

	Poor Stand	Fair Stand	Good Stand
Alfalfa	0	36	71
Red Clover	0	18	36
Red Clover (2 yr)	0	9	18
Soybean	0	9	9
Annual ryegrass	0	0	-13

Source: PEI Dept of Agriculture & Fisheries

Nutrient Recommendations for Potato (lb/ac)**:**

	N Russet Burbank	N Prospect	P_2O_5	K_2O
L-	185	120-135	400	270
L	185	120-135	275	200
M	185	120-135	200	135
M+	185	120-135	200	135
H	185	120-135	135	135
H+	185	120-135	135	135

Per soil test results from PEI Analytical Laboratory

Source: PEI Dept of Agriculture & Fisheries

Nutrient Levels from PEI Soil Health Survey

	Mean	Min	Max
P_2O_5	452	25	854
K_2O	98	35	315
Mg	89	28	280
Ca	809	332	2234

Nutrients expressed in ppm. Source: Dalhousie University/PEIDAF

Timing and Placement of Application:

Different nutrients should be treated differently when it comes to timing and placement. Ideally nutrients should be easily available at the time of plant demand, which differs by nutrient and the time of the growing season.

Increasingly, nitrogen is being applied in multiple applications, as applying all nitrogen before or after planting can increase the risk of N loss through leaching. Additionally, very high N rates early in the season can result in delayed tuberization, slow skin development, and reduced specific gravity.

Splitting applications between pre-plant, at planting, top-dressing, and foliar applications can help to mitigate possible N losses from premature nitrification of ammonium into nitrate. Coated N products (such as ESN) or products with urease/nitrification inhibitors (such as Super-U) can also be used to reduce the risk of early season N loss and increased availability during tuber bulking, the time of greatest N requirement.

Potassium (K) is required in even greater quantities than nitrogen; however, applying all of that K at once, banded at planting, can be problematic. High spring K application rates have been associated with yield reductions. If using muriate of potash (KCl), its high salt index has been linked to lower specific gravity. Due to its relative immobility in soil, K can be effectively broadcast in the fall or spring before planting. Splitting application between broadcast pre-plant application and low-salt index K sources (ie. potassium sulfate) in the planter blend is recommended. Late season application of K is not generally recommended.

Phosphorus (P) also has slow mobility in soil and stays where it is applied, resulting in banded application at planting as the recommended practice. However, a primary concern with P is its risk of becoming bound by aluminum in acidic soils. To help mitigate this, many producers are applying P as an in-furrow liquid application or as a late season foliar application.

Calcium (Ca) is generally agreed to be deficient in PEI soils, and many forms of soil Ca are not readily available to growing plants. Application of Ca through gypsum broadcast and incorporated before planting or as a liquid application at planting/hilling are gaining popularity for increasing Ca uptake by plants for tuber fortification.

Additional Resources:

A&L Laboratories Canada
http://www.alcanada.com

PEI Analytical Laboratory
https://www.princeedwardisland.ca/en/information/agriculture-and-fisheries/pei-analytical-laboratories-peial

4R Nutrient Stewardship Online Training
https://fertilizercanada.ca/nutrient-stewardship/elearning/4r-nutrient-stewardship/

PEI Potato Nitrogen Recommendation Worksheet
https://www.princeedwardisland.ca/sites/default/files/publications/af_nmp_potnwork-1.pdf

PEIDAF Nutrient Management Resource Page
https://www.princeedwardisland.ca/en/information/agriculture-and-fisheries/what-nutrient-management-planning

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